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ABSTRACT

The Zimbabwe Secondary School Science Project (ZIM-SCI) developed student study guides, corresponding teaching guides, and science kits for a low-cost science course which could be taught during the first 2 years of secondary school without the aid of qualified teachers and conventional laboratories. This ZIM-SCI study guide presents activities and experiments for a 2-week unit on energy. The unit starts by asking students to observe what is happening around them and relates these observations to energy. This is followed by experiments on heat, light, kinetic (motion), electrical, and potential (stored) energy. After these experiments have been completed, the concepts of energy conversions and energy chains are established. Sources of energy are then discussed, starting with food, then coal and oil, and their origin traced to the sun. A final section focuses on alternative energy sources (hydroelectricity and solar energy). Two summaries are included to highlight the important aspects of the unit. Information to help students understand the scientific principles behind the activities and experiments is also provided. (JN)

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ZIM–SCI

ZIMBABWE SECONDARY SCHOOL SCIENCE PROJECT

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STUDY GUIDE UNIT B

What makes things happen?

SE 043 832

UNIVERSITY OF ZIMBABWE
AND MINISTRY OF EDUCATION AND CULTURE

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March 1981

Zim - Sci

Zimbabwe Secondary School Science Project

GENERAL SCIENCE

STUDENTS : Please read this carefully. It will help you.

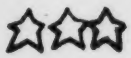
How you will study

This study guide comes to you with a kit of apparatus. Both things are part of a study programme leading you to an understanding of aspects of science. In this course you will be carrying out experiments. The study guide will help you to understand the scientific principles behind the experiments.

Your work should be done as you are instructed, either by the teacher or the study guide.

To help you to see quickly what you must do, the study guide uses these symbols.

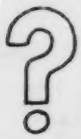
for "Read special notes".



for "Take note of an important point that you should learn."

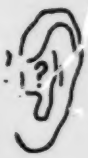
for "Summary". This is to help you to go over what you have learned.

for "Experiment".
When you see this sign, read the instructions carefully from beginning to end before you start to do the experiment.



for "How much do you know?"
This is for you, to help you to test whether you are remembering what is important.

for "Written work". This is when you must answer questions in writing.



for Listen to the teacher and do exactly what the teacher tells you to do

GENERAL SCIENCE

UNIT B : WHAT MAKES THINGS HAPPEN ?

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UNIT B

AIMS OF THIS UNIT

When you have completed this unit, you will be able to:

1. Describe energy in terms of change.
2. Describe those changes which you observe.
3. List several different forms of energy.
4. State ways in which one form of energy may be converted to other forms.
5. Construct energy chains.
6. Describe how all food material and fuels are derived from plants.
7. State energy sources which can be renewed and those that cannot be renewed.
8. Describe how most energy is derived from the sun.
9. State that energy cannot be created or destroyed.
10. Identify food intake as a process which releases energy to living organisms.

GENERAL SCIENCE UNIT B

Look around your school. You will see various changes happening. For example, leaves of trees on the school grounds may be moving. They move because they have ENERGY. They get the ENERGY from the wind which is blowing. The bus you usually see moves on the road because it has energy.

The bus gets its ENERGY from diesel. In the engine the diesel and air are mixed and burnt.

This produces ENERGY which the bus uses to move on the road.

DIAGRAM 1

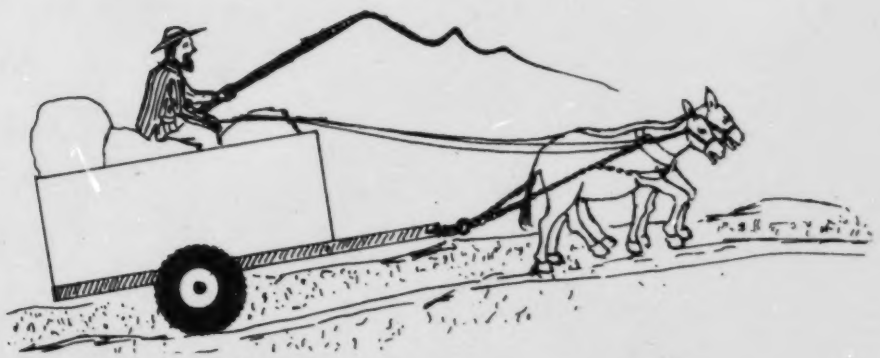
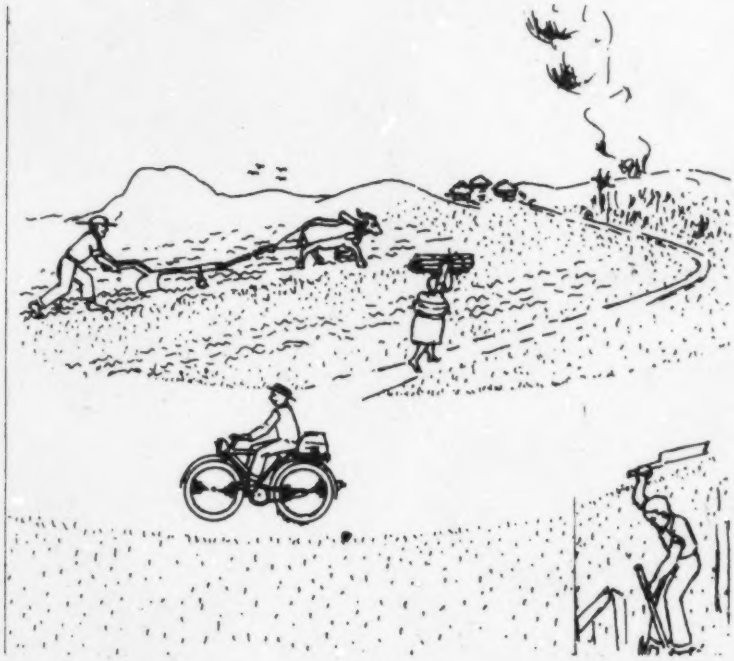


Diagram (1) shows donkeys pulling a cart. You can tell they have ENERGY because the cart and donkeys are moving. You will notice that ENERGY causes CHANGES to happen.

Count all the CHANGES you notice happening in Diagram 2

DIAGRAM 2



Can you hold ENERGY?

It is not possible to hold it and put it in your pocket. In fact you see it working only when it causes CHANGES to happen.

Here are the experiments you will do on ENERGY at work.

Before starting these experiments copy into your exercise book the table your teacher has put on the board. Are you ready to start the first experiment?

EXPERIMENT 1

For this experiment you will need a piece of magnesium metal, a piece of wire, your burner.

1. Light your burner.
2. Bend the magnesium like this.

3. Hang magnesium on the burnerstand like this.

4. Use your burner to light the end of the magnesium.

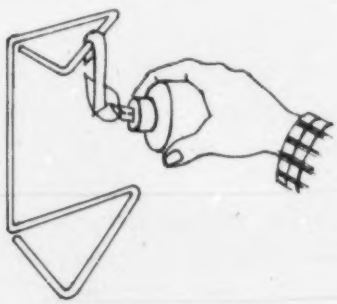


DIAGRAM 3

5. When things have stopped happening, carefully feel the stand.

CARE: Do not look at the magnesium flame directly, because it is very bright and will damage your eyes. Now blow the burner flame out and put the stand back into your kit.

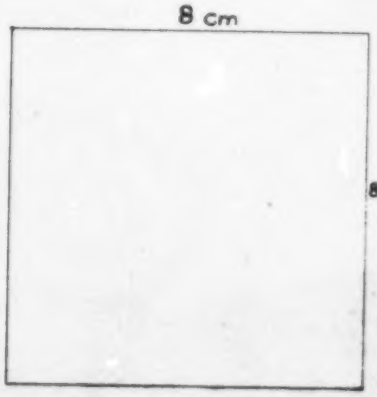
Remember I said you can only tell that energy is there by what it does. You saw energy making things happen. What did it do to the stand? Did you feel anything? Well that was one form of energy. Why did I ask you not to look at the magnesium flame directly? If you burnt magnesium in a dark room, the room would not be dark, it would be ? ?
That is another form of energy.

Now be ready to do another experiment on energy at work.

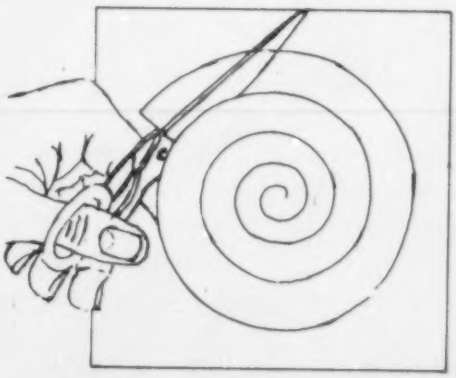
EXPERIMENT 2

You will use a paper spiral and so you will need to make one for yourself. This is how to make it. You will need: Paper (an old newspaper will do), a pair of scissors.

You will also need: a thread 30 cm long, a sharp pencil, Your burner.

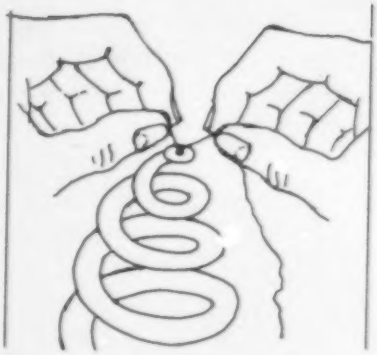


Cut a piece from your paper this size.



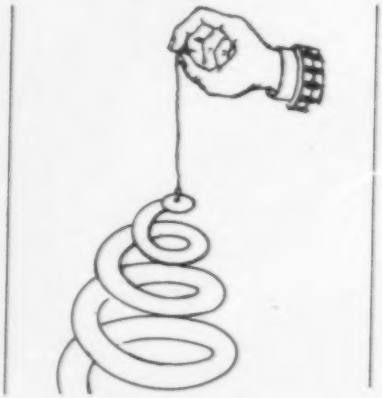
Draw a spiral line on the paper with your pencil like this.

Cut along the spiral line like this.



Your spiral now looks like this. Now you are ready to use your spiral.

Make a hole at the small end of the spiral using your sharp pencil. Tie the spiral so that when you hold the thread it hangs like this.



Hold your spiral above your burner. Light your burner. Now hold your spiral above the flame.

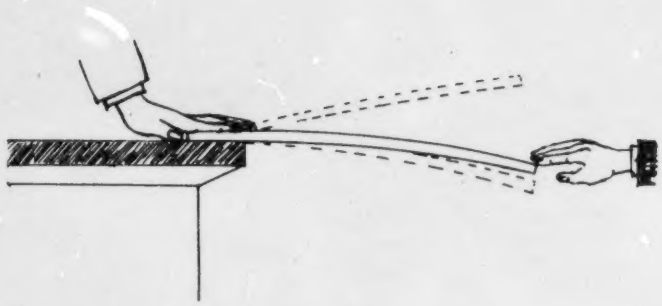
CARE: Do not hold the spiral too near the flame or it will catch fire!

What did you observe happening in this experiment? When you held the spiral above the flame it started to spin very fast. There was a change in the movement of the spiral. The spiral had a lot of MOTION energy. Scientists call this KINETIC energy. Moving things have KINETIC energy. Where do you think the spiral got its kinetic energy from? Think about this question carefully.

Your third experiment is simple. This time you will only need your ruler.

EXPERIMENT 3

DIAGRAM 4



Place one end of your ruler on your desk and press it hard against your desk with your hand. Now twang the other end of the ruler with your fingers. What do you observe?

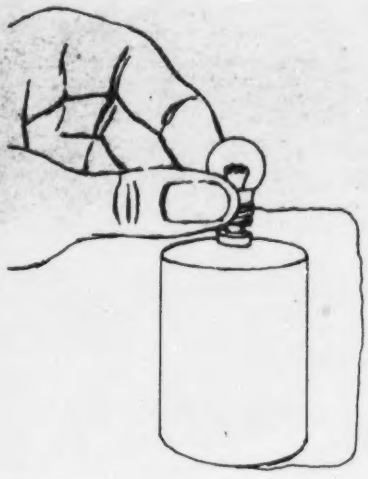
That was an interesting experiment wasn't it? I am sure you enjoyed it. Was energy causing changes here? Maybe you will get the idea if you think about what you observed happening. Your classroom was filled with a lot of noise produced by twanging rulers. They were producing another form of energy which you were able to hear. You noticed also that your ruler was moving up and down as it produced this energy. Your fingers produced kinetic energy and sound energy in the ruler. Where did all this energy come from? Now put your rulers away and get ready for the next interesting experiment.

EXPERIMENT 4

For this experiment you will need: a torch battery.
1 piece of copper wire.
a torch bulb.

Connect the torch battery to the bulb with the piece of copper wire like this (Diagram 5)

DIAGRAM 5



Ask your teacher if you need help.
Feel the bulb. Remove the copper wire. Feel the bulb again.

Some energy changes happened here. The bulb was hot when you joined it to the battery. It was also shining brightly. You observed two kinds of energy: heat energy and light energy. Where did all this energy come from this time? Maybe it will help you if you think about why I asked you to remove the one copper wire.
Do you still remember what happened when you did this? The energy change required the battery, the wire and the torch bulb all connected together. This is called a complete CIRCUIT. The battery has energy which produced the changes in the bulb. If you look at the bulb very closely, there are very thin wires inside. This is where the energy change takes place. The battery energy is often called ELECTRICAL energy. It is the same energy which is stored in radio batteries. The complete circuit allowed the energy to go from the battery to the bulb.

If you have not been filling in the table for Exercise 1 as you have been doing the experiments, stop and fill it in now.

EXPERIMENT 5

Here you will need: a spatula
an evaporating dish
a substance called potassium manganate
a liquid substance called glycerol

1. Push the potassium manganate in your evaporating dish into a pile in the middle. Use the spatula to do this.
   Look at the colour of potassium manganate
   Feel the bottom of the dish
2. Add five drops of glycerol to the potassium manganate If nothing happens in a minute add a drop of water to the mixture. Now feel the bottom of the tin again. Look at the colour of potassium manganate. Put the dish on your stand and wait until nothing more happens. Write down everything you observed in this experiment (Exercise 2)

Throw away the mixture and clean your evaporating dish and dropper with a lot of water.

The bottom of the dish became hot after adding glycerol. Changes happened. Even the colour of potassium manganate changed! You observed several kinds of energy. Where did these kinds of energy come from? In the world around you there are many substances. We call these substances chemicals. Some chemicals are solids, some liquids and others gases. Potassium manganate and glycerol are two chemicals. The heat you felt came from mixing the two chemicals. When chemicals are mixed and heat is produced, they are said to be REACTING. Change always happens when chemicals react.

Which other experiment showed a chemical reaction? Chemicals have energy stored in them. This CHEMICAL energy changes into heat during a reaction.

EXPERIMENT 6

For this experiment you will need:

a rubber band

a stone

a piece of string or thread

1. Tie the rubber band to the stone with the string or thread as shown in Diagram 6.

DIAGRAM 6

2. Hold the stone hard against your desk top.
3. Now pull the other end of the rubber along the desk.
4. Release the stone. Observe what happens.

The stone got kinetic energy. Where did this energy come from?
The rubber stretched when you pulled it didn't it? Its length changed. That needed energy. You gave it some of your energy as you pulled it. It stored this energy as it stretched. Stored energy is POTENTIAL energy. If your teacher calls you a POTENTIAL scientist, he means you are capable of being a scientist. You are not one yet. You will be one if you work hard in science. The stretched rubber is capable of pulling the stone, but does not do so before the stone is released.

Energy has many forms, here is another simple experiment on yet another form of potential energy.

EXPERIMENT 7

This time you will go outside.
So you will have time to stretch yourself!
Do not use too much of your energy! Find a stone or a piece of brick you can lift. This will use some of your energy too!

Lift the stone above your head and down again as many times as you can. Finally allow the stone to drop on the ground and return to your classroom.

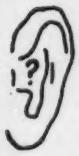
Did you feel tired after lifting the stone many times? Do you think you lost energy? I am sure you have seen things falling. Ripe fruits fall from a tree. Maybe you once fell from a fruit tree! The stone fell from your hand. All these show energy at work. You gave the stone some of your energy as you lifted it. The stone stored this energy as POTENTIAL energy. It was capable of falling. It fell when you dropped it.
Everything that goes up comes down again. It is because the earth is pulling it. This pull of the earth is called GRAVITY.

Your stone was pulled to the ground by gravity when you dropped it. The pull of gravity gave the stone POTENTIAL energy while it was held up there. Remember Experiment 5 when you caused chemicals to react. That chemical energy was stored before they reacted and so was another form of potential energy!

From all the experiments you have done you can see that many things have energy e.g. the magnesium burning in air, the spinning spiral, the twanging ruler, the battery and the chemicals.
So energy appears in many forms. The magnesium flame has LIGHT and HEAT energy. The spinning spiral has MOTION or KINETIC energy, the twanging ruler has SOUND energy,the battery has ELECTRICAL energy and the chemicals have CHEMICAL potential energy.

you have learnt a lot about forms of energy and what they do. We asked you to think about where the energy came from, did you think about where it went to? Can you guess where the energy went to in Experiment 7? Doing the experiment again will probably help you to decide.

Now you will do some experiments to find out if you are correct in your ideas about energy.



EXPERIMENT 8 - A thinking experiment!

Close your eyes - your teacher is going to tell you a story!

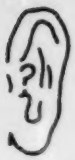
As you lifted the pot you gave it some of your energy as kinetic energy. The pot stored the energy as gravitational potential energy. Then you dropped the pot. It got kinetic energy as it dropped. Crash: on the ground. Ah! Another form of energy!
How many forms of energy did the pot go through? Count them. Which energy came first? Which came last? One energy form leads to another. One energy form is CONVERTED to another form.

Lift the tin kinetic energy	tin up Potential energy	tin drops kinetic energy	bang on the ground Sound energy

(There will be another form of energy that you will feel when your mother finds out you have broken her pot!)

The energy forms are connected to each other like the links in a chain.
Does the chain end with sound energy?
Our limited senses tell us that this is so. After a while you did not hear the crashing sound so the energy must have changed into some other form.
Our senses cannot help us to notice all the changes that happen. The Potential energy which you gave to the pot came from your body. In your body there are also many energy changes which you cannot see.

You have observed many energy conversions in your daily life. Your teacher will now show you another interesting one to think about.



EXPERIMENT 9

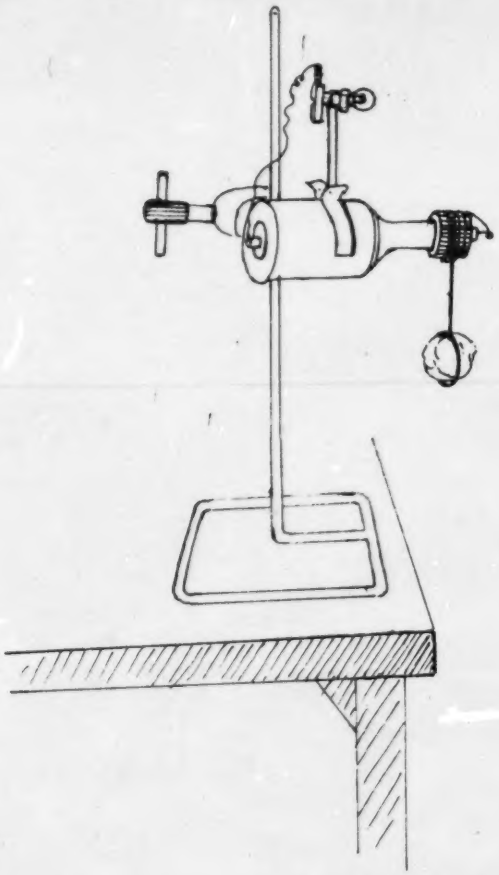


DIAGRAM 7

This picture shows the things your teacher has used. Do you see the bicycle generator (dynamo), the torch bulb and the connecting wire? Can you see the string and the stone?

The stone had energy before it dropped. You remember the form of energy it had. Where did it get this energy? As the stone dropped it changed this form into another form of energy. The dynamo turned as the stone dropped. It got kinetic energy. This energy was converted into another form by the dynamo. The new form of energy was shown in the bulb. Here again you meet an energy chain.

Draw this energy chain in your exercise books (Exercise 3)

You remember an energy chain does not end, it continues. A dynamo converts kinetic to electrical energy. You will learn about other useful energy converters later.

Can the energy chain you have observed be reversed? It is not possible to convert light from the bulb to electrical energy. However your teacher will show you another converter which can do this.

EXPERIMENT 10: Using solar cells to convert the light energy to electrical energy.

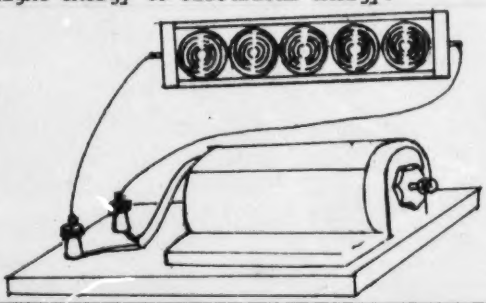


DIAGRAM 8

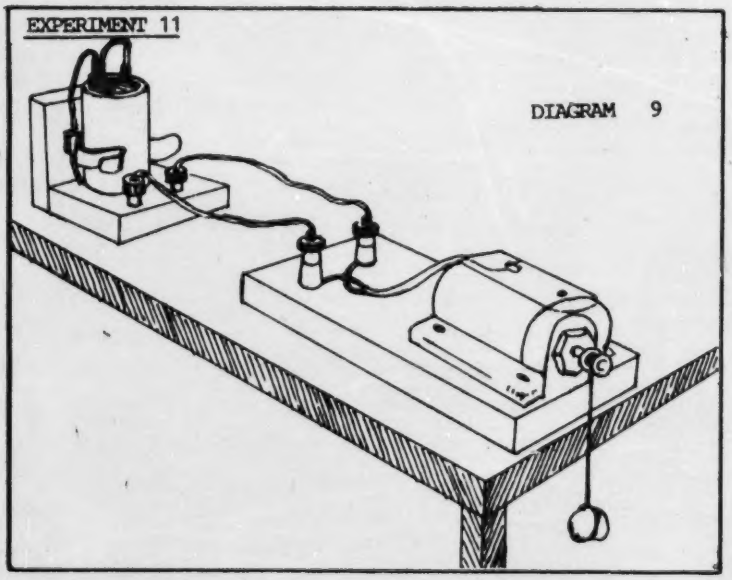
Solar cells are a new invention and may be important suppliers of energy in the future.

Here is another interesting experiment which your teacher will show you.

This experiment is similar to Experiment 10 but uses a chemical battery instead of solar cells.

EXPERIMENT 11

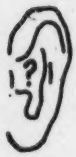
DIAGRAM 9



Your teacher has used the things in the picture. You will notice the stone, the battery, the motor and the connecting wires. These are connected together to form a complete circuit. Remember we talked about a complete circuit in Experiment 4.

There were many forms of energy seen in this experiment. Did you count them? The energy from the battery was converted into another form by the motor. The motor then pulled the stone up. Inside the battery there were also energy changes happening. You could not see them because the battery was closed. Chemicals react to produce energy inside a battery. When you get home try to find an old torch battery. Bring it to school for your teacher to open it up.

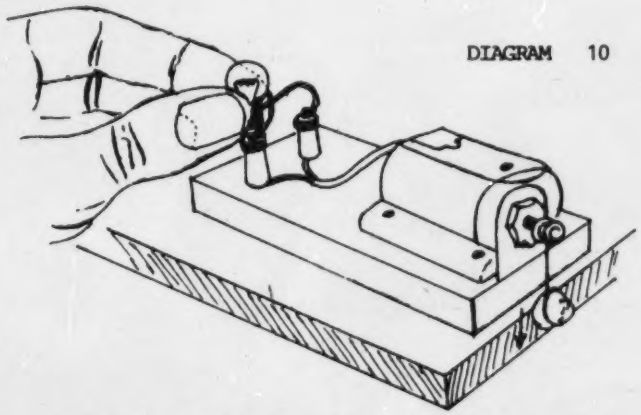
You will learn more about batteries later in the course.



The stone had potential energy when it was up. Can you guess what happens when the stone is allowed to drop? Your teacher will show you.

EXPERIMENT 12

DIAGRAM 10



Your teacher has now put a torch bulb in the circuit. You will notice that the battery has been taken away.

Energy changes happened here again. One form of energy is converted into another form. The stone drops. It turns the motor as it drops. That is an energy conversion. The motor turns and the torch bulb shines. That is yet another energy conversion. Electric energy was used to lift the stone. When the stone dropped electric energy was produced.

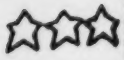
In Experiment 11 the energy flowed from the battery through the wires and was stored in the stone when it was pulled up.

What was the source of energy in Experiment 11 ?
How did the energy flow this time ?

In Experiment 11 the motor converted electrical energy to kinetic energy (the stone moved). In Experiment 12 the motor converted kinetic energy (the stone falling) to electrical energy (which caused the torch bulb to give out light.)
The motor did the same job as the dynamo in Experiment 9 so we should call it a dynamo in this experiment.

If you think about what you have just read it means that this energy chain through the motor is reversible.

In all the experiments you did on energy changes, you did not observe energy being made out of nothing. You did not observe energy changes disappearing completely into nothing.



ENERGY IS NEVER CREATED OR DESTROYED. It is simply converted from one form to another.

Answer Exercise 4 in your book.

What you have learnt about energy so far.

1. ENERGY is involved when a change happens.
2. ENERGY can take the form of light energy, heat energy, kinetic energy, sound energy, electrical energy and various forms of potential energy.
3. ENERGY can be stored, for instance in chemicals, stretched rubber, or in anything lifted up.
4. In an energy chain, energy is converted from one form to another.
5. Energy is never created or destroyed.

If energy is never created or destroyed where does it come from and go to then?
For animals, YOU included, the answer may seem simple. You get your energy from food. Think about what you ate yesterday or this morning. I am sure sadza, porridge or bread are some of the foods you ate. All these contain chemicals called carbohydrates.
You will now do an experiment on carbohydrates using mealie meal as an example.

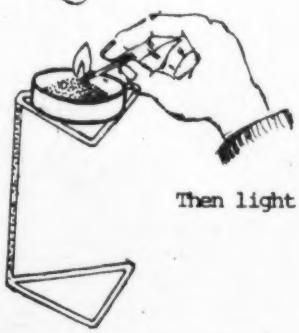
EXPERIMENT 13

You will need: your evaporating dish
some mealie meal
burner and stand

Pour a small heap of mealie meal into an evaporating dish.

Heat the mealie meal on the stand until it starts to burn.

Remove the burner.

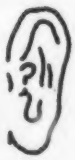


Then light the mealie meal with a match.

Answer Exercise 5

You saw that carbohydrates produce energy when they burn in air. In your body a chemical reaction occurs between carbohydrates and part of the air you breathe in. Unlike burning in air, this reaction takes place slowly and at low temperatures. You use the energy released during this reaction for moving and doing work.

If you think deeply you will see that whatever you eat comes from plants. Your teacher will discuss this important idea with you. What about things which are not living? What are the energy sources for cars, buses and trains? A car uses petrol, a bus uses diesel and a train uses coal. Petrol, diesel and coal are fuels. Fuels are sources of energy.



It is a wonderful thing that <u>all</u> fuels also come from plants! Coal and oil are very important fuels, and therefore important sources of energy. You will be interested to see how these fuels were formed and your teacher will tell you more about it.

Fuels and foods containing stored energy come from plants. Energy cannot be created from nothing. Where do you think the <u>plants</u> got their energy from?

An experiment will help you to find out the answer to this question.

<u>EXPERIMENT 14</u>

Have a look at the plants you grew in Unit A2. One of your plants was growing in a dark place, the other one was growing in a place which received sunlight.

Look carefully at each of the plants and make a list of all the differences you notice. (Exercise 6.)

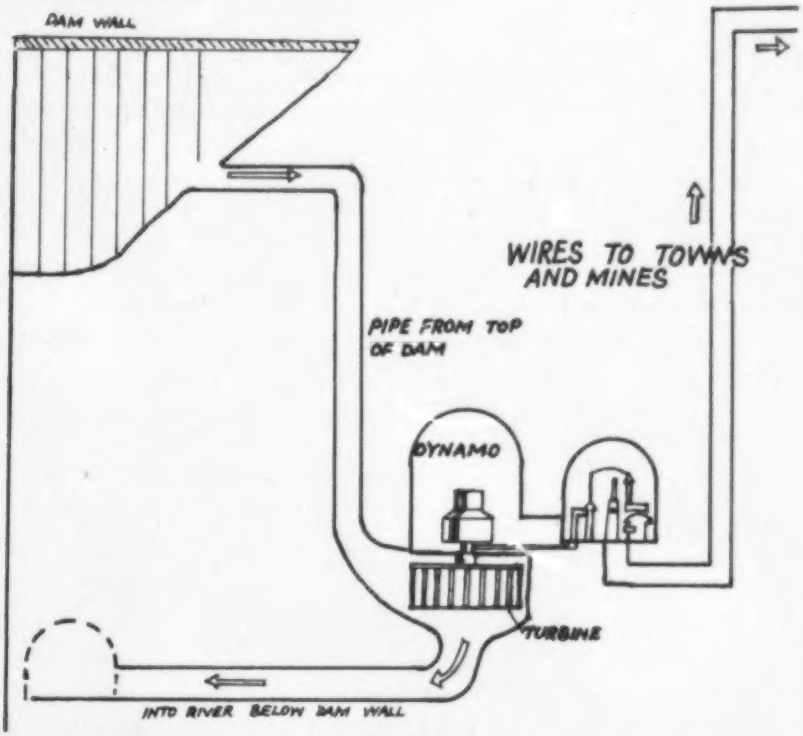
Plants need the sun to grow well. All green plants get their energy directly from the sun. They use the light and heat energy from the sun to make food.

☆☆☆ THIS IS THE MOST IMPORTANT REACTION ON EARTH.

It is the reaction on which all animals depend. The same reaction caused the energy in coal and oil to build up.

☆☆☆ ALL THE ENERGY WE USE IN ZIMBABWE COMES FROM THE SUN.

As you learnt, coal and oil take a long time to build up and yet they are used daily. These fuels are slowly being used up. You can imagine the trouble people will face if they are used up. However, scientists have discovered other ways that give us energy without burning fuels.



This picture, Diagram 11, shows what happens at Kariba. The water has a lot of potential energy. The water comes rushing down through pipes, changing its potential energy into kinetic energy. This energy turns the big dynamos to make electrical energy. The electrical energy is then carried to towns and mines on long wires. There it is changed to other useful forms of energy. The energy for turning dynamos comes from the water. How does the water get its potential energy at Kariba ?

EXPERIMENT 15

You will need: Your evaporating dish
Some water

1. Pour a little water into your evaporating dish. (one or two drops)
2. Place the tin outside in the sun. Look at the water towards the end of the lesson.

Some of the water has gone. It has gone into the air. It has evaporated. The heat from the sun turned the water into a gas called water vapour. This water vapour went into the air. In the same way, the sun turns water in rivers and seas into water vapour. The vapour goes into the air. It is cooled up there to form drops of water. These drops come down as rain. The rain water then flows into the Zambezi River to be stored at Kariba Dam. So through the heat energy of the sun water has been raised up and held in the Dam to give it potential energy.

There are other ways in which the energy from the sun is put to our use. You have already experimented with one way. (Experiment 10) Another way is to use SOLAR HEATERS. In these, the sun heats pipes which contain water. The water becomes hot and is stored in tanks. From these tanks it can be used for washing.

Perhaps you might like to try and make a solar heater? Your teacher will talk to you about this.

To finish off this unit complete Exercise 7.

What you have learnt about ENERGY sources.

1. Animals get their energy from the food they eat.
2. Animals depend on plants for their food.
3. Green plants get their energy directly from the sun.
4. Oil and coal which come from living things contain stored energy.
5. Oil and coal cannot be replaced. They are slowly being used up.
6. Scientists have discovered sources of energy other than fuels, such as oil and coal.

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